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# A SIPHONOSTOME COPEPOD ASSOCIATED WITH A VESTIMENTIFERAN FROM THE GALAPAGOS RIFT AND THE EAST PACIFIC RISE[1]

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*Abstract*—*Ceuthoecetes aliger,* new genus, new species, a siphonostome copepod belonging to the new family Dirivultidae Humes and Dojiri (in press) occurs on the tentacular crown of a large vestimentiferan living in warm water near hydrothermal vents on the Galapagos Rift and the East Pacific Rise.

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Two species of copepods are known as associates of Vestimentifera Webb, 1969, a group of tubicolous marine worms placed in the Pogonophora by Webb (1969) but among the Annelida by van der Land and Nørrevang (1977). The clausidiid *Tychidion guyanense* Humes, 1973, is associated with *Lamellibrachia luymesi* van der Land and Nørrevang, 1977, in 500 m off Guyana. *Dirivultus dentaneus* Humes and Dojiri, in press (new family Dirivultidae), occurs on the tentacular crown of *Lamellibrachia barhami* Webb, 1969, in 1125 m, off southern California. This paper includes the description of a third species of copepod, this time from the tentacular crown of a large vestimentiferan from the Galapagos Rift and the East Pacific Rise. The worms from these two areas, tentatively identified as the same species, are presently under study by Dr. Meredith L. Jones, National Museum of Natural History, Smithsonian Institution.

The vestimentiferans, living in warm water near hydrothermal vents on the Galapagos Rift (about 380 km northwest of the Galapagos and 1,000 km west of Ecuador) and the East Pacific Rise (about 250 km south of the tip of Baja California), were collected during dives by the submersible *Alvin,* operated by the Woods Hole Oceanographic Institution (see Corliss *et al.,* 1979).

Three preserved vestimentiferans were washed gently in 70 percent ethyl alcohol, making sure that the alcohol passed freely between the many lamellae on the tentacular crown. The copepods were recovered from the sediment obtained after passing the solution through a fine net (openings about 100 $\mu$m square). The first vestimentiferan yielded 34 adults and 17

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copepodids; the second 1 adult and 6 copepodids; and the third 2 adults and 18 copepodids. The total number was 37 adults and 41 copepodids.

The study of the copepods was aided by grant DEB 77 11879 from the National Science Foundation.

All measurements were made on specimens in lactic acid. The figures were drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: $A_1$ = first antenna and MXPD = maxilliped.

## *Dirivultidae* Humes and Dojiri, in press

## *Ceuthoecetes,* new genus

*Diagnosis.*—Siphonostomatoida, Dirivultidae. Body unmodified. Urosome 5-segmented in female, 6-segmented in male. Caudal ramus with six setae. Rostrum not well defined. First antenna 10-segmented, with aesthete on next to last segment. Prehensile second antenna with minute exopod and 2-segmented endopod with one terminal claw.

Oral cone short. Mandible a long slender blade with serrate tip, lacking palp. First maxilla with small outer lobe. Second maxilla prehensile, second segment merging with long slender claw. Maxilliped prehensile and 4-segmented with terminal claw.

Legs 1–3 with 3-segmented rami. Leg 4 with 3-segmented exopod and 2-segmented endopod. Formula for endopod 0-0; I,1. Legs 1–4 alike in both sexes.

Leg 5 sexually dimorphic, in female placed laterally with four setae on free segment and dorsal seta absent, in male placed ventrally with five setae on free segment and "dorsal" seta present. Leg 6 in female lacking identifiable setae or spines but perhaps represented by two small processes on genital area, in male with two setae on posteroventral flap on genital segment.

Other features as in species described below.

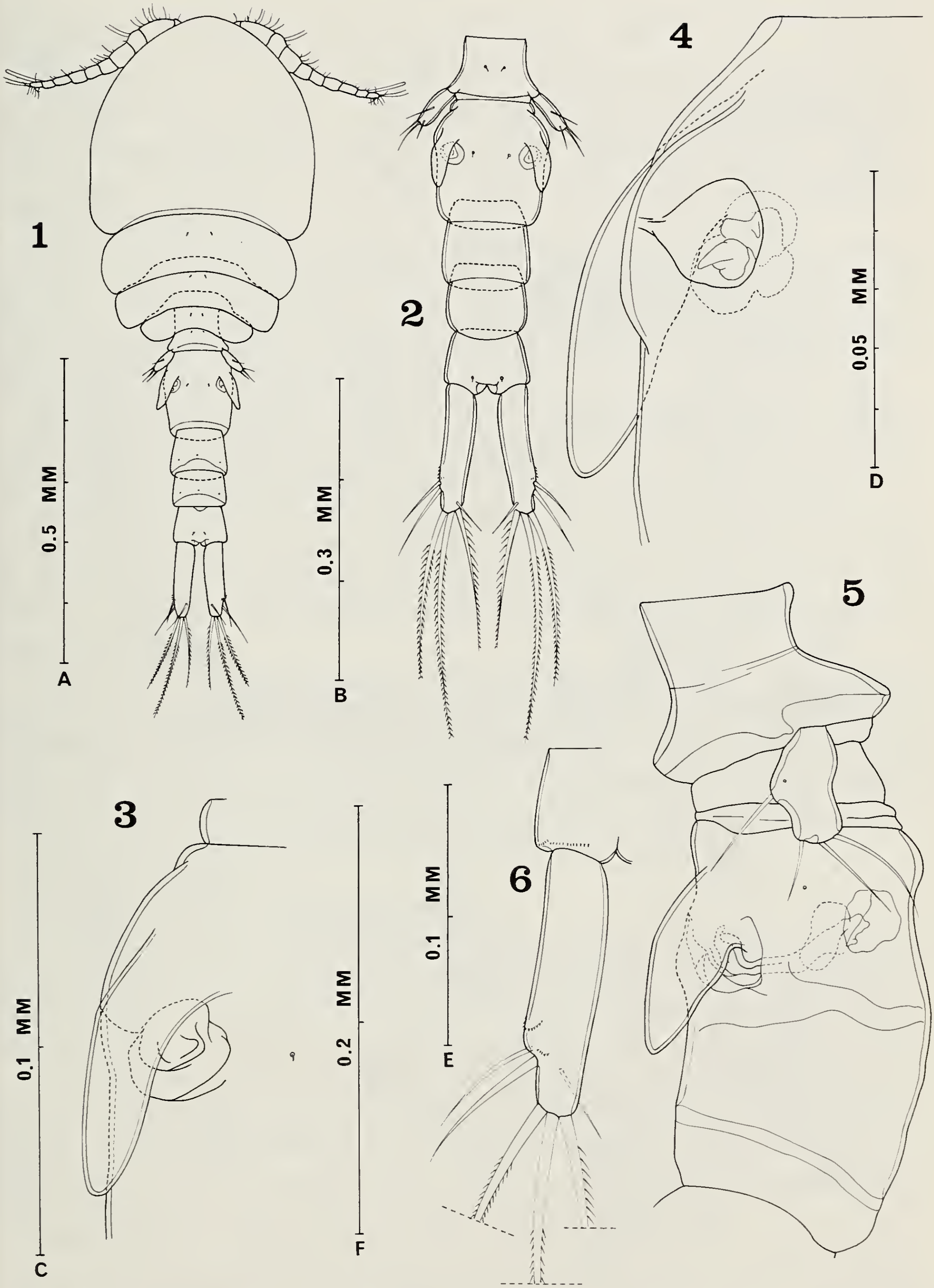
Associated with Vestimentifera.

*Type-species.*—*Ceuthoecetes aliger,* new species.

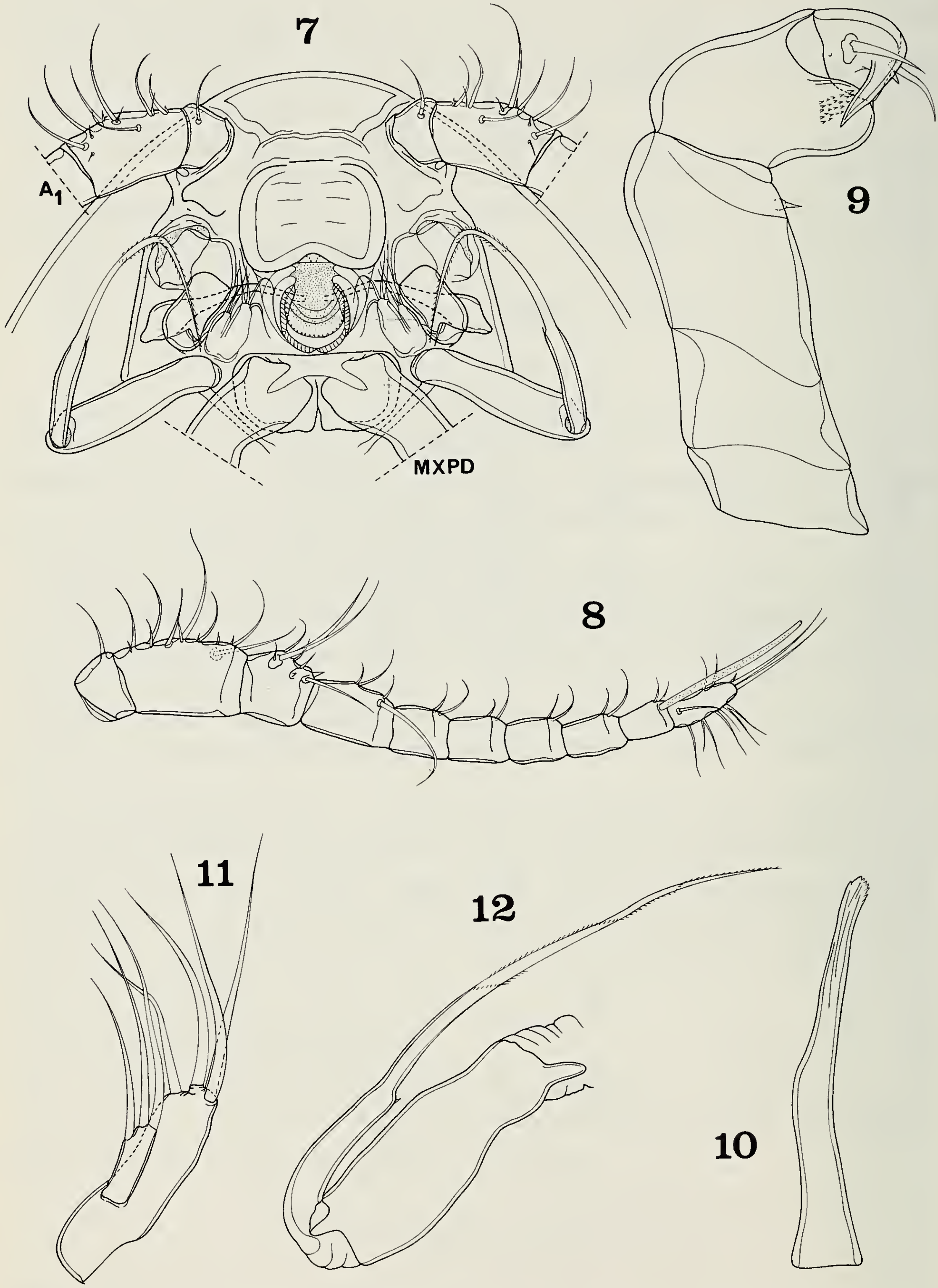
*Etymology.*—The generic name is a combination of κευθος, the depths, and οικητης, an inhabitant. Gender masculine.

## *Ceuthoecetes aliger,* new species
Figs. 1–28

*Type-material.*—8 ♀♀, 26 ♂♂, and 17 copepodids from one large vestimentiferan in 2,595 m, *Alvin* dive no. 915, East Pacific Rise, 20°51′N, 109°4.9′W, 22 April 1979. Holotype ♀, allotype, and 25 paratypes (4 ♀♀, 21 ♂♂) deposited in the National Museum of Natural History, Smithsonian




Figs. 1–6. *Ceuthoecetes aliger,* female: **1,** Dorsal (A); **2,** Urosome, dorsal (B); **3,** Genital area, dorsal (C); **4,** Genital area, ventral (D); **5,** Segment of leg 5 and genital segment, lateral (E); **6,** Caudal ramus, ventral (F).




Figs. 7–12. *Ceuthoecetes aliger*, female: **7,** Oral area, ventral (F); **8,** First antenna, ventral (F); **9,** Second antenna, antero-inner (D); **10,** Mandible, posterior (D); **11,** First maxilla, posterolateral (C); **12,** Second maxilla, posterior (C).

Institution, Washington, D.C.; the remaining paratypes (dissected) and the copepodids in the collection of the first author.

*Other specimens.*—1 ♀, 6 copepodids from part of the tentacular crown of 2 large vestimentiferans, in 2,482 m, *Alvin* dive no. 884, Garden of Eden site, Galapagos Rift (see Corliss *et al.,* 1979), 0°48.1′N, 86°7′W, 25 January 1979; 1 ♀, 1 ♂, and 18 copepodids from one entire large vestimentiferan, same locality and date.

*Female.*—Body (Fig. 1) cyclopoid. Length 1.02 mm (0.94–1.15 mm) and greatest width 0.36 mm (0.36–0.37 mm), based on 10 specimens. Segment of leg 1 not separated from cephalosome. Epimeral areas of segments of legs 1–4 rounded. Ratio of length to width of prosome 1.40:1. Ratio of length of prosome to that of urosome 1.08:1.

Segment of leg 5 (Fig. 2) 59 × 84 μm. Genital segment 130 × 111 μm, only slightly expanded laterally in anterior third where segment bears a pair of prominent digitiform dorsoposteriorly directed lobes approximately 62 × 16 μm (Figs. 3, 4, 5). Genital areas (Figs. 3, 4, 5) lacking identifiable setae or spines but with two small conical processes about 5 μm and 11 μm (Fig. 4). Three postgenital segments from anterior to posterior 92 × 92, 70 × 84, and 59 × 81 μm. Anal segment with posteroventral row of small spines on each side (Fig. 6).

Caudal ramus (Fig. 6) elongate, 122 × 32 μm, ratio 3.81:1. Outer lateral seta 59 μm, dorsal seta 46 μm, outermost terminal seta 68 μm, all smooth. Innermost terminal seta 132 μm, with inner hairs. Two median terminal setae 167 μm (outer) and 232 μm (inner), both bilaterally barbed. Ventral surface of ramus near lateral seta with two rows of minute spinules.

Body surface with few small hairs (sensilla) as in Figure 1.

Egg sac unknown.

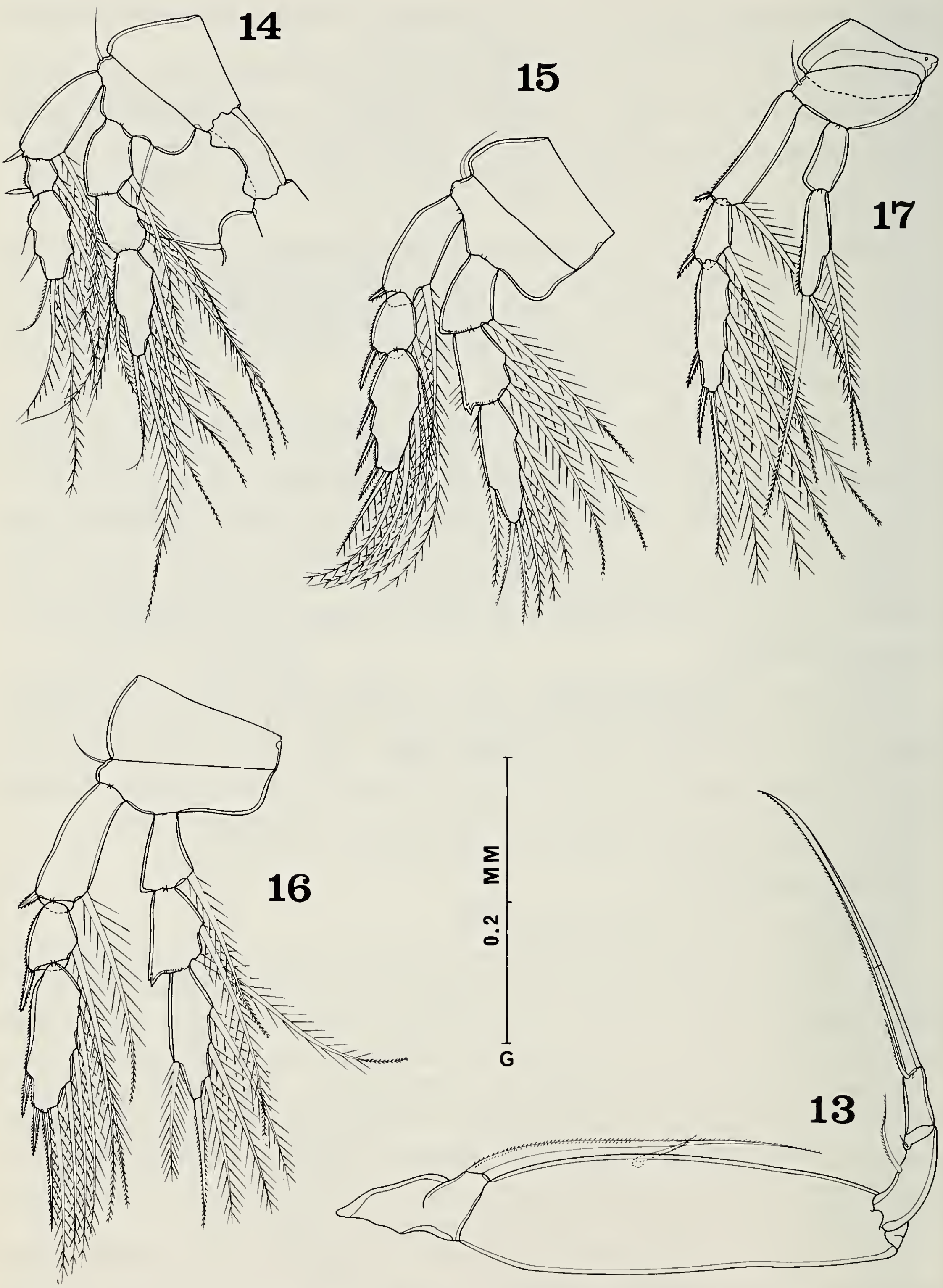
Rostral area (Fig. 7) not well defined.

First antenna (Fig. 8) 10-segmented and 288 μm long. Lengths of segments (measured along their posterior nonsetiferous margins): 8 (20 μm along anterior margin), 43, 27, 41, 27, 27, 27, 30, 22, and 27 μm respectively. Formula for armature: 1, 13, 9, 4, 2, 2, 2, 2, 2 + 1 aesthete, and 12. All setae smooth.

Second antenna (Fig. 9) 4-segmented, 124 μm long. Protopod 2-segmented but coxa subdivided, giving appearance of three segments. Exopod a minute process. Endopod 2-segmented, first segment slightly swollen with patch of small spines distally on antero-inner surface; second segment bearing three naked setae and a recurved claw approximately 30 μm long.

Labrum (Fig. 7) broad with posteroventral margin weakly indented. Oral cone short with incomplete dentate inner ring (Fig. 7).

Mandible (Fig. 10) a long slender blade 65 μm with finely serrate tip. Paragnath not seen. First maxilla (Fig. 11) with small outer lobe having three setae, large inner lobe with four setae, all setae smooth. Second max-




Figs. 13–17. *Ceuthoecetes aliger,* female: **13,** Maxilliped, posterior (F); **14,** Leg 1 and intercoxal plate, anterior (G); **15,** Leg 2, anterior (G); **16,** Leg 3, anterior (G); **17,** Leg 4, anterior (G).

illa (Fig. 12) with elongate first segment 78 × 25 μm including proximal blunt spinelike process. Second segment merging with long slender claw, forming functional claw 157 μm long provided distally with small spinules. Maxilliped (Fig. 13) 4-segmented. First segment small with long spinulose inner seta. Second segment elongate, 189 × 54 μm, with short inner seta. Third segment 51 μm long with two very unequal setae. Fourth segment 27 μm, with one seta and two minute spinules. Claw nearly straight, 135 μm, obscurely subdivided and bearing short spinules along inner side.

Ventral area between maxillipeds and first pair of legs without special sclerotization.

Legs 1–4 (Figs. 14, 15, 16, 17) biramous, with all rami 3-segmented except for 2-segmented endopod of leg 4. Formula for armature as follows (Roman numerals indicating spines, Arabic numerals representing setae):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $P_1$ | coxa | 0–0 | basis | 1–1 | exp | I–1; | I–1; | II,I,4 |
| | | | | | enp | 0–1; | 0–2; | 1,2,3 |
| $P_2$ | coxa | 0–0 | basis | 1–0 | exp | I–1; | I–1; | III,I,4 |
| | | | | | enp | 0–1; | 0–2; | 1,2,3 |
| $P_3$ | coxa | 0–0 | basis | 1–0 | exp | I–1; | I–1; | II,I,5 |
| | | | | | enp | 0–1; | 0–2; | 1,1,3 |
| $P_4$ | coxa | 0–0 | basis | 1–0 | exp | I–1; | I–1; | II,I,4 |
| | | | | | enp | 0–0; | I,1 | |

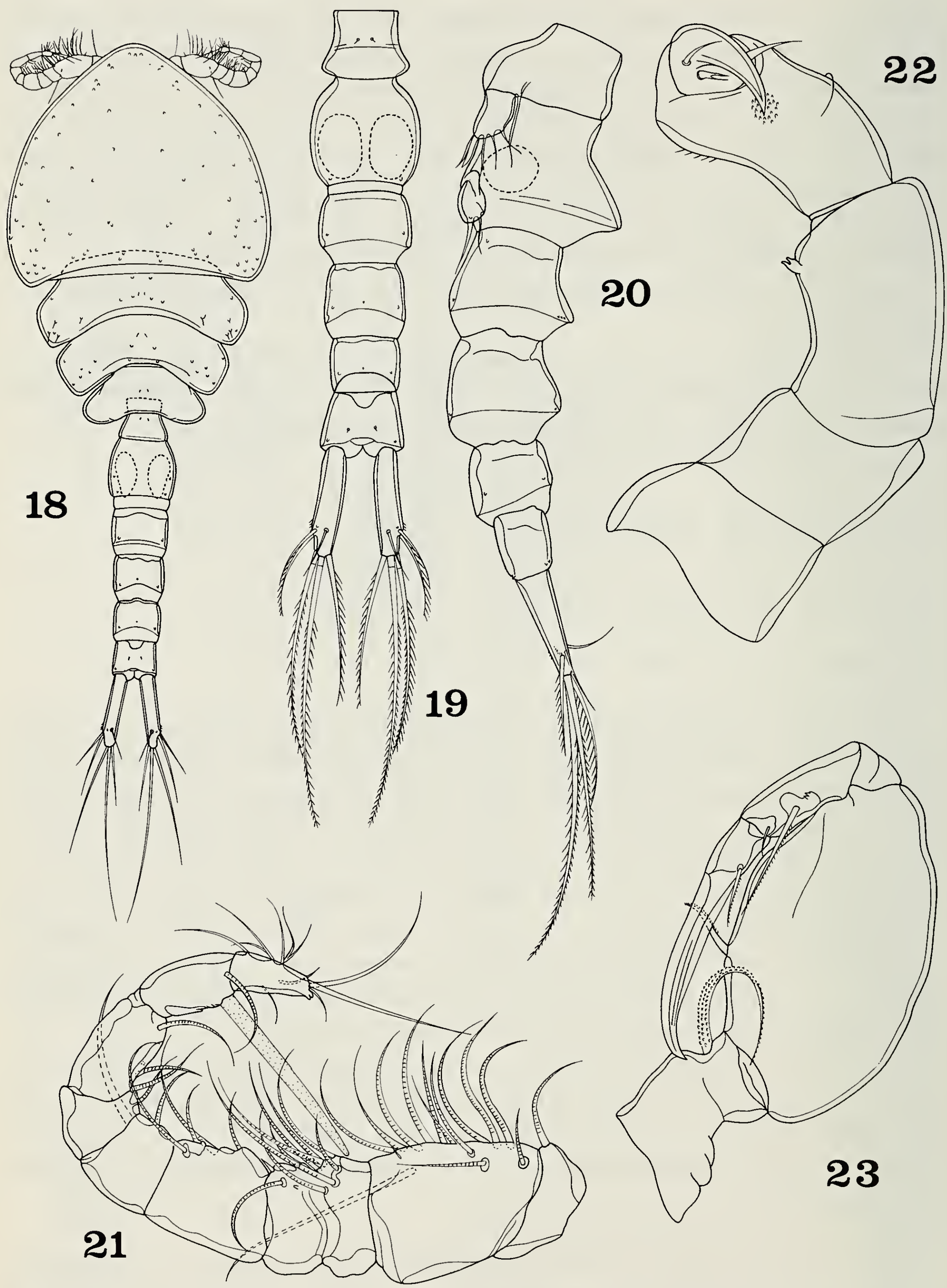
Leg 1 (Fig. 14) with intercoxal plate bearing pair of processes on ventral margin. Basis with smooth inner seta 43 μm long. Outer spines on exopod weak and setiform. Proximal five inner setae on endopod with short spinules near tips instead of long hairs. Outer margin of first endopod segment smooth (as in legs 2–4 also). Leg 2 (Fig. 15) and leg 3 (Fig. 16) with bifurcate distal outer process on second endopod segment and with several setae showing short distal spinules as in leg 1. Leg 4 (Fig. 17) with exopod 216 μm. Endopod with smooth unarmed first segment 49 × 21 μm; second segment 76 × 21 μm, with terminal barbed spine 146 μm and inner seta 151 μm, segment with small spinules along outer margin.

Leg 5 (Fig. 5) irregular in form, unornamented, greatest dimensions 43 × 22 μm (16 μm wide in distal part), bearing four smooth setae from dorsal to ventral 32, 22, 32, and 46 μm. Dorsal seta absent.

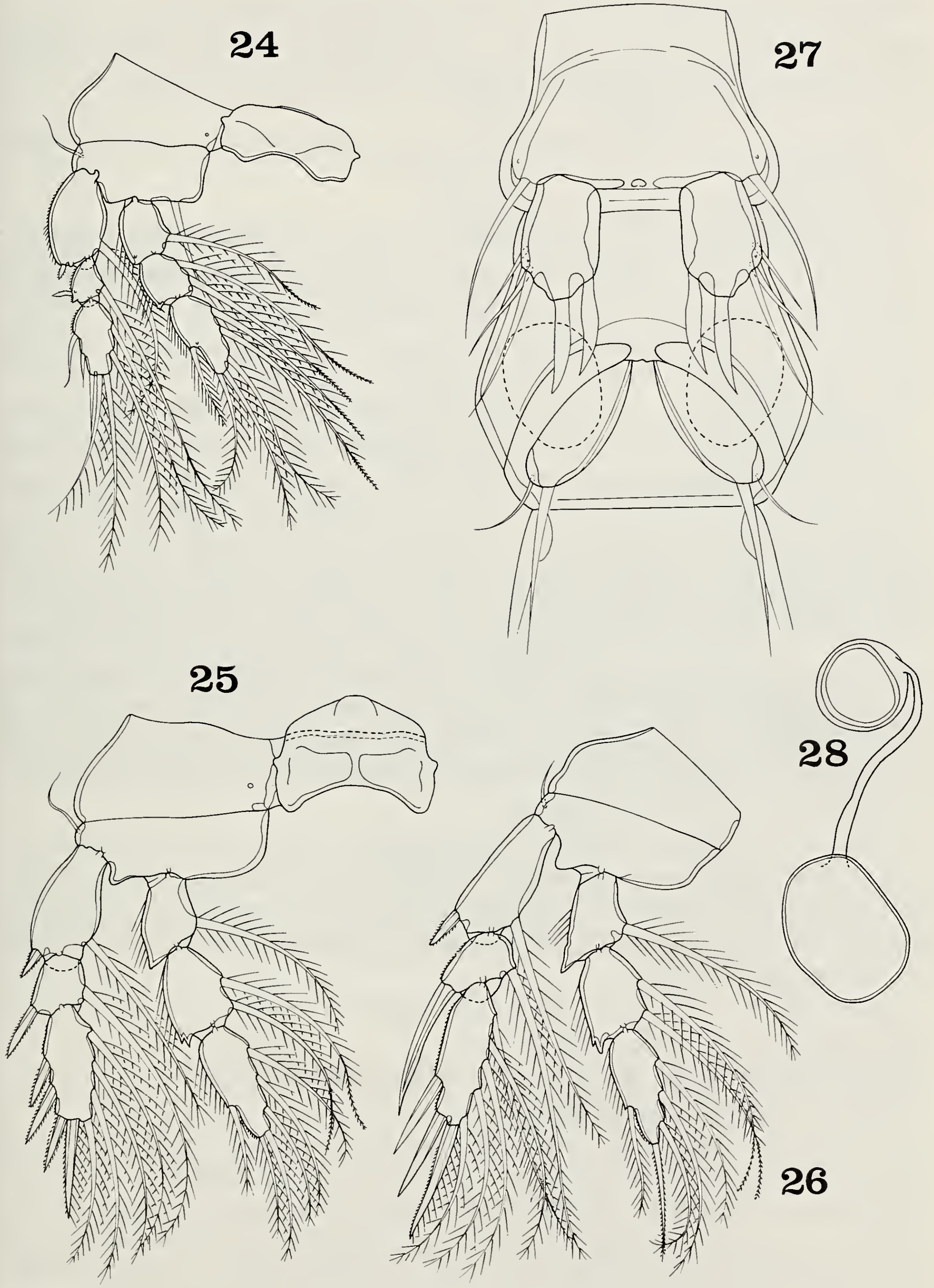
Leg 6 perhaps represented by pair of small conical processes on genital area (Fig. 4).

Color in living specimens unknown.

*Male.*—Body (Fig. 18) with cephalosome a little broader than in female. Length (excluding setae on caudal rami) 1.14 mm (1.03–1.29 mm) and greatest width 0.42 mm (0.37–0.45 mm), based on 10 specimens. Ratio of length to width of prosome 1.39:1. Ratio of length of prosome to that of urosome 1.31:1.




Figs. 18–23. *Ceuthoecetes aliger,* male: **18,** Dorsal (A); **19,** Urosome, dorsal (B); **20,** Urosome, lateral (B); **21,** First antenna, ventral (E); **22,** Second antenna, antero-outer (D); **23,** Maxilliped, posterior (F).




Figs. 24–28. *Ceuthoecetes aliger,* male: **24,** Leg 1 and intercoxal plate, anterior (G); **25,** Leg 2 and intercoxal plate, anterior (G); **26,** Leg 3, anterior (G); **27,** Legs 5 and 6, ventral (E); **28,** Spermatophore, as attached to genital area of female (E).

Segment of leg 5 (Fig. 19) 81 × 81 μm. Genital segment 118 × 113 μm, almost quadrate in dorsal view, but with prominent dorsal ridge in lateral view (Fig. 20). Four postgenital segments from anterior to posterior 76 × 86, 76 × 81, 59 × 70, and 65 × 70 μm.

Caudal ramus resembling that of female but a little smaller, 113 × 27 μm, ratio 4.2:1.

Body surface and rostrum as in female.

First antenna (Fig. 21) 10-segmented, recurved, length if straightened approximately 318 μm. Lengths of segments (measured along their posterior nonsetiferous margins): 19 (27 μm along anterior margin), 41, 22, 22, 46, 30, 30, 46, 35, and 30 μm respectively. Armature: 1, 14, 7, 4, 4, 2, 2, 2 + minute knob, 1 + aesthete + 2 small knobs, and 11 + bifid knob.

Second antenna (Fig. 22) resembling that of female but small exopod bifid. First endopod segment with inner ridge and few small outer spinules, and second endopod segment with one seta bifurcate. Labrum, oral cone, mandible, first maxilla, and second maxilla as in female. Paragnath not seen. Maxilliped (Fig. 23) with formula for armature as in female. Seta on first segment spinulose. Second segment stouter than in female. Claw 84 μm, much shorter than in female and relatively stouter and more unguiform.

Legs 1–4 having same segmentation and formula for armature as in female. First segment of endopod in all four legs with outer hairs (these hairs absent in female). Leg 1 (Fig. 24) with inner seta on basis 78 μm long. Leg 2 as in Figure 25. Exopod of leg 3 (Fig. 26) with outer spines 30, 103, 59, 65, and 89 μm from proximal to distal. (In female these spines 13, 28, 27, 29, and 82 μm). Leg 4 as in female.

Leg 5 (Fig. 27) placed ventrally. Free segment without fine ornamentation, 43 × 32 μm, with five smooth setae, two inner setae broad and 34 μm long, three outer setae slender, from outer to inner 31, 40, and 61 μm. Seta near insertion of free segment (corresponding to usual dorsal seta, but here moved ventrally) 78 μm.

Leg 6 (Fig. 27) a posteroventral flap on genital segment bearing two unequal smooth setae 51 μm and 70 μm.

Spermatophore (Fig. 28) oval, 57 × 41 μm, with long neck.

Color in living specimens unknown.

*Etymology.*—The specific name *aliger,* Latin meaning winged, alludes to the pair of winglike lobes on the genital segment of the female.

*Remarks.*—*Ceuthoecetes aliger,* new genus, new species, appears to be related to *Dirivultus dentaneus* Humes and Dojiri, in press, described from the vestimentiferan *Lamellibrachia barhami* Webb, 1969. The nature of the first maxilla, the prehensile character of the second maxilla, and the segmentation and armature of legs 1–4 provide evidence for this affinity. Furthermore, the general appearance of the mandible, a very conservative appendage, reflects this presumed relationship.

There are, however, fundamental differences between *Dirivultus denta-*

Table 1.—Comparison between *Dirivultus dentaneus* Humes and Dojiri, in press, and *Ceuthoecetes aliger,* new genus, new species.

| | *Dirivultus* | *Ceuthoecetes* |
|---|---|---|
| First antenna | | |
| Female | 13-segmented | 10-segmented |
| Male | 12-segmented | 10-segmented |
| Exopod of second antenna | 1-segmented | Small process |
| Third segment of exopod of leg 3 | III,I,5 | II,I,5 |
| Leg 5 | | |
| Female | Minute free segment with 1 seta | Large free segment with 4 setae |
| Male | Distinct free segment with 2 setae | Free segment with 5 setae |

*neus* and *Ceuthoecetes aliger* (Table 1). Although the differences which exist between the two species concerning the first antenna and leg 5 are thought to be important, we believe at this time that *Ceuthoecetes* can be accommodated within the family Dirivultidae.

The two collections of *Ceuthoecetes aliger* are separated by about 3,700 km. This suggests that other populations are likely to be discovered along the intervening oceanic ridge system as other vent communities are studied.

## Acknowledgments

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